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Description of Early Larvae of Four Northern California Species of Rockfishes (Scorpaenidae: *Sebastes*) from Rearing Studies

Guillermo Moreno

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A Technical Report of the *Fishery Bulletin*

Description of Early Larvae of Four Northern California Species of Rockfishes (Scorpaenidae: *Sebastes*) from Rearing Studies

Guillermo Moreno

November 1993

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Description of Early Larvae of Four Northern California Species of Rockfishes (Scorpaenidae: *Sebastes*) from Rearing Studies

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ABSTRACT

About 72 species of *Sebastes* (Family Scorpaenidae) are found along the eastern Pacific coast of North America, some of which are heavily exploited by both commercial and sport fisheries. Because of the large number of species, the identification of early life stages has progressed slowly. The objectives of this study were 1) to rear the larvae of four species of rockfish (*Sebastes mystinus, S. carnatus, S. atrovirens,* and *S. rastrelliger*); and 2) to describe the larvae using morphometric measurements, pigmentation patterns, and head spination.

Pigmentation was the most useful feature for identification purposes. Two general patterns were found: 1) a short row of ventral midline melanophores on the tail, and none or very little postero-dorsal pigmentation (*S. mystinus*); and 2) complete ventral midline pigmentation on the tail, and anterior and postero-dorsal melanophores (*S. carnatus, S. atrovirens,* and *S. rastrelliger*). With the exception of very early stages of *S. carnatus* and *S. atrovirens,* these species can be readily identified. Morphometric proportions and head spination did not show major differences among species.

Because of the great similarities found among species in this genus, descriptions from field studies are uncertain to some extent. Laboratory rearings, although difficult, can at least provide early larvae from known species which allow precise identification as well as an estimation of variability of characters (e.g., pigmentation) within and between broods.

Introduction

The genus *Sebastes* (Rockfishes; Family Scorpaenidae) is an abundant and diverse group of fishes along the Pacific coast of North America (Love and Westphal, 1981) including about 72 species in 11 nominal subgenera (Kendall, 1991). The group is an important part of the commercial and sport catches off California, Oregon, Washington, Canada, and Alaska (Moser et al., 1977; Gunderson and Lenarz, 1980; Lenarz, 1987). In California, rockfishes represent one third of the recreational fish catch; *S. mystinus, S. melanops,* and *S. flavidus* compose up to 30% of this proportion. *Sebastes mystinus* is also an important component of the commercial rockfish catch (Lenarz, 1987).

Species identification of early life history stages is critical for systematics as well as for studies using larval abundance for population estimates. In the genus *Sebastes,* many larval characters are shared by many closely related species, making determination and evaluation of the importance of characters difficult (Moser et al., 1977; Moser and Ahlstrom, 1978; Barsukov, 1981; Kendall and Lenarz, 1987). Larval rearing can provide essential identification information and permit an evaluation of variation in diagnostic characters of larvae from different ages, broods, and species. The relative importance of these diagnostic characters may then be evaluated.

Rockfishes are viviparous, extruding a few hundred thousand to over two million larvae (e.g., *S. paucispinis*; Moser, 1967) during an annual spawning season. The newly extruded larvae are born with little yolk, but with well-developed eyes and mouths that allow immediate feeding (Boehlert and Yoklavich, 1984).

Partial descriptions are available for the larvae of 51 eastern Pacific rockfish species (Matarese et al.,

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1989); many important commercial and recreational species remain undescribed. Early developmental stages traditionally have been described from larvae extruded in the laboratory and from preserved field collected specimens (Morris, 1956; Moser, 1967, 1972; Waldron, 1968; Westrheim, 1975; Moser et al., 1977; Moser and Ahlstrom, 1978; Richardson and Laroche, 1979; Laroche and Richardson, 1981; Moser et al., 1985). Also larvae have been reared from known parents through the stage of caudal-fin formation (Moser and Butler, 1981; Stahl-Johnson 1984, 1985; Moser and Butler, 1987, Kendall 1989[1]; Wold, 1990).

Efforts to rear larval *Sebastes* in captivity have met with varying success. Japanese workers have raised larvae of eight northwestern Pacific species, three of these to the juvenile state (*S. pachycephalus* [Fujita, 1957; Siokawa and Tsukahara, 1961]; *S. oblongus* [Fjuita, 1958]; and *S. schlegeli* [Hoshiai, 1977; Kusakarai et al, 1977]). However, only recently have eastern Pacific *Sebastes* larvae been raised past yolk absorption and, in some cases, to caudal-fin formation (Moser and Butler, 1981, 1987; Stahl-Johnson, 1985; Kendall, 1989[1]; Wold, 1990). Factors responsible for difficulties in rearing northeastern Pacific species may include their relatively small size at birth (<4.5 mm) and cool ambient water temperatures that slow growth rates relative to western Pacific species (Kendall and Lenarz, 1987).

The purposes of this study were 1) to rear larvae of four rockfish species that are widely distributed along the west coast of North America (Eschmeyer et al., 1983) and are associated with kelp beds or nearshore rocky reef areas, or both, and 2) to describe their early development. The species studied were blue (*S. mystinus*), gopher (*S. carnatus*), kelp (*S. atrovirens*), and grass (*S. rastrelliger*) rockfishes.

Methods

Collection

Gravid females of *S. mystinus* (n=4) and *S. carnatus* (n=3) were collected at Stillwater Cove, Carmel Bay, California, between December and May 1988 and 1989. Rockfishes were captured by SCUBA divers using hook-and-line or gill nets and transported to the Monterey Bay Aquarium (MBA). Gravid females of *S. atrovirens* (n=2) and *S. rastrelliger* (n=1) from the Kelp Tank at the MBA were also used in this study. All females were placed in rearing tanks until after parturition. Food (squid, krill, and anchovies) was offered to all females before parturition, but no feeding was observed.

Rearing

Rearing tanks with black walls and white conical bottoms held 400 L of continuous flowing (3–4 L/min) of filtered (1 µm) seawater. The flowthrough system was similar to that of Hughes et al. (1974), differing only in the direction of the flow, which in this study was from top to bottom. At parturition, or soon after, the females were removed from the rearing tanks, and larval densities were reduced to <10 larvae/L (as recommended by Stahl-Johnson, 1985) by siphoning excess larvae until desired densities were reached.

Larvae were fed with a variety of food organisms. Larvae up to one week old were fed 3–4 times per day with the marine rotifer *Brachionus plicatilis* and wild plankton. The plankton was collected daily in Elkhorn Slough, Monterey County, CA, with a 30–µm net. All items that passed through a 120–µm mesh were fed to the larvae. Possible prey items observed included rotifers, copepods, tintinnids, nauplii, trochophore larvae, and phytoplankton, mainly diatoms. After the first week, brine shrimp (*Artemia* spp.) nauplii (San Francisco Bay Brand, Inc., Newark, CA) were added to the diet. The wild plankton was then filtered to 220–µm to allow larger prey items in the tanks, but to avoid introduction of possible predators and other fish larvae.

The reared rotifers were fed cultured algae (*Tetraselmus* spp., *Phaeodactylum* spp., *Isochrysis* spp., and *Duniolella* spp.; Guillard, 1975) and were enriched daily with a mixture of fish oil (herring) and egg yolk (1:1)[2]. The *Artemia* nauplii were enriched with "Selco" (Artemia Systems N.V., Belgium), and the wild plankton was treated with a fungicide-bactericide (1–10 ppm; "Prefuran," Argent Labs., Redmond, WA) to reduce the possibility of bacterial contamination of the larval rearing tanks. During the first rearing season, water quality samples were taken weekly and analyzed for nitrate, nitrite, phosphate, ammonia, and oxygen levels. Owing to consistently high quality of the water system, these tests were later discontinued. Continuous lighting was used to allow 24–hour feeding.

Descriptions

Larval fish were sampled (numbers depending on availability) every four to five days for descriptive work, photographs, and preservation. Larvae were fixed initially in 5% buffered (sodium borate) forma-

[1]Kendall, A. W., Jr. Additions to knowledge of *Sebastes* larvae through recent rearings. Dep. Commer., NOAA, Northwest and Alaska Fisheries Center Processed Report 89–21, 46 p.

[2]Refik Orhun, Hubbs Marine Research Center, San Diego, CA 92101. Pers. Commun.

lin, and then transferred after 30 days to a dehydrating series of isopropanol (25–50%) and ethanol (70%), allowing a week between each alcohol change. Initially, measurements were taken before and after fixation and dehydration to determine possible shrinkage. No changes were noted so subsequently larvae were measured only after preservation.

Morphometric and pigmentation analyses were conducted on dehydrated larvae for 0.5–mm SL size classes within the available size range (e.g., 3.0–7.9 mm) for each species. Morphometric measurements included standard length (SL); snout-anus length (SA); head length (HL); snout length (SnL); eye diameter (ED); and body depth at pectoral fin base (BD) (Moser et al., 1977; Moser and Ahlstrom, 1978). Body proportions (SA/SL; HL/SL; SNL/HL; ED/HL; BD/SL) were calculated and means, standard deviations, and ranges were obtained for each size group of each species.

A modification of the pigment scheme of Kendall and Lenarz (1987) of melanophore presence or absence at 26 loci was used. Pigmentation analysis of 33 loci (Fig. 1) assessed the presence and number of melanophores for loci 4, 6, 18, and 19, and the presence (given as proportions) of melanophores for the rest of the loci. Loci 4, 6, 18, and 19 were treated differently because melanophores at these loci could be counted with confidence. It was also possible to count the number of melanophores in loci 22 and 23 for *S. mystinus*. The other loci had tightly packed melanophores that made counts impossible in most cases. Because of the large observed variability in

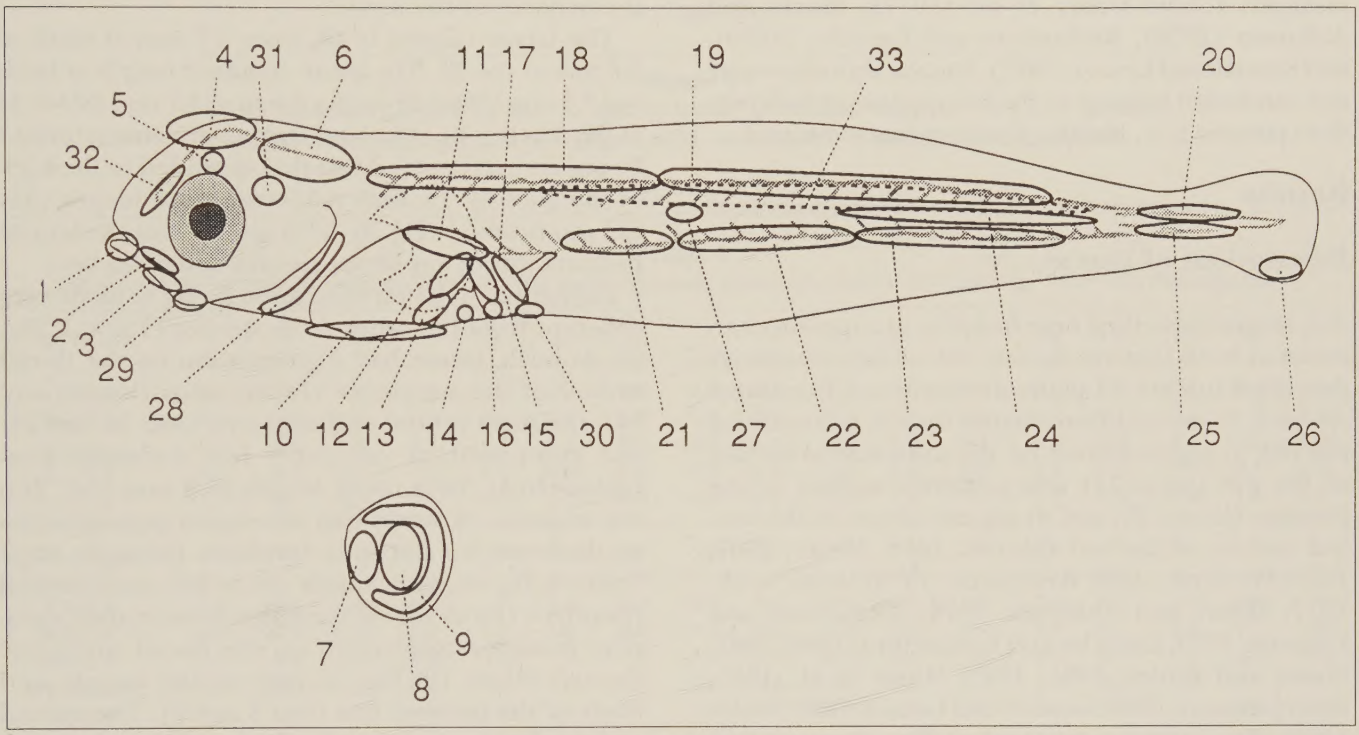

Figure 1

Diagram of 33 melanophore positions found on *Sebastes* larvae. Positions are as follows (pectoral fin loci (7, 8, and 9) are shown separately): Locus: **1** = symphysis of the lower jaw; **2** = upper jaw; **3** = lateral aspect of the lower jaw; **4** = dorsal surface of the brain from the front to the back of the eye; **5** = lateral surface of the brain from the front to the back of the eye; **6** = dorsal surface from the back of the eye to the front of the cleithrum; **7** = base of the pectoral fin; **8** = blade of the pectoral fin; **9** = margin of the pectoral fin; **10** = ventral aspect of the gut; **11** = dorsal aspect the gut; **12** = postero-dorsal surface of the gut; **13** = postero-ventral surface of the gut; **14** = ventral membrane between anus and gut; **15** = inside surface of the anus; **16** = border of the anus; **17** = outside surface of the anus; **18** = dorsal midline from above the cleithrum to the the 3rd postanal myomere; **19** = from the postanal myomere to the last myomere; **20** = from the last myomere dorsally along the notochord to the hypural plates (if present); **21** = first to 3rd or 4th postanal myomere; **22** = third or 4th to 6th or 7th postanal myomere; **23** = 7th to 19th postanal myomeres; **24** = lateral aspect of the body from the 6th or 7th to the 19th postanal myomere; **25** = from the last myomere ventrally along the notochord to the hypural plates (if present) or to the end of the notochord; **26** = ventral aspect of the caudal fin; **27** = lateral aspect of the body from the 1st to the 5th postanal myomere; **28** = cleithral symphysis; **29** = lower jaw symphysis; **30** = fin fold behind the anus; **31** = otic area; **32** = olfactory lobe; **33** = internal locus above the dorsal surface the notochord from the 3rd to the 19th postanal myomere. (Modified after Kendall and Lenarz, 1987.)

melanophore development, proportions of larvae by size class with pigment at each locus were noted in this study.

Common pigmentation sites in *Sebastes* larvae include the dorsal and lateral surfaces of the gut (loci 11, 12, 15, and 17), dorsal midline of the tail (loci 21–23), pectoral fins (loci 7–9), nape (locus 4), dorsal aspect of the head (locus 6), upper and lower jaws (loci 1–3, and 29), and caudal fin (loci 20, 25, and 26) (Kendall and Lenarz, 1987). Means, standard deviations, and ranges of melanophore numbers at these loci were calculated for each 0.5–mm SL size class.

Descriptions were done with dissecting microscopes (10–60×). An Olympus image analysis system (CUE II) was employed for the morphometric measurements. Illustrations conform to the guidelines in Sumida et al. (1984); descriptive terminology and methods follow Moser et al. (1977), Moser and Ahlstrom (1978), Richardson and Laroche (1979), and Kendall and Lenarz (1987). Statistical analyses were not conducted because of the low number of independent samples (i.e., birthing females) that were used.

Results

Descriptions of Larvae

The species described here had several common characters at birth that are shared with all *Sebastes* species described to date: 1) pigmented eyes and functional mouths; 2) an undifferentiated finfold surrounding the tail; 3) pigmentation on the dorsolateral surface of the gut (locus 11) and posterior surface of the hindgut (locus 17); and 4) pigmentation on the ventral surface of the tail (Morris, 1956; Moser, 1967, 1972; Waldron, 1968; Westrheim, 1975; Moser et al., 1977; Moser and Ahlstrom, 1978; Richardson and Laroche, 1979; Laroche and Richardson, 1980, 1981; Moser and Butler, 1981, 1987; Moser et al., 1985; Stahl-Johnson, 1985; Kendall and Lenarz, 1987; Wold, 1990). The extent of postanal midline pigmentation helps to separate groups of species (DeLacy et al., 1964; Moser, 1967; Westrheim, 1975; Moser et al., 1977). In this study, the larvae of *S. mystinus* had short ventral series of melanophores (loci 22 and 23), which are different from the longer, denser series (loci 21–23) characteristic of the other three species (*S. carnatus, S. atrovirens,* and *S. rastrelliger*). In addition, *S. mystinus* lacked, or had very little, pigmentation on the dorsal portion of the tail (locus 19). This contrasted with the other three species which had complete dorsal series (loci 18 and 19).

Sebastes mystinus—Larvae were obtained from three females during January and February 1989. Two broods were born; one with fully absorbed yolk and the other with large (0.6–mm mean diameter) yolk sacs. The latter brood had higher mortalities and the larvae were often seen at the surface swimming on their sides and occasionally upside down owing to the buoyancy of the yolk sacs and oil globules. Larvae from these two broods lived 10 and 11 days, respectively. A third female gave birth to larvae, some of which survived 31 days. Some larvae from this brood showed signs of starvation such as dorsoventrally compressed heads, "duck billed" jaws, and reduced body depths. At 28 days the marine copepod *Tigriopus californicus* was introduced into the diet of this brood to supplement the rotifer-brine shrimp nauplii-wild plankton diet. This copepod proved to be an unsuitable food item because of its large size and to its aggregation along the sides of the tanks away from the majority of the larvae.

The larvae ranged in SL from 3.2 mm at birth to 5.5 mm at day 31. The mean standard length at birth was 3.8 mm (SD=0.2), with a mean of 4.7 mm (SD=0.4) at day 31 (Fig. 2). The later stages were characterized by pigmented pectoral fins that extended to the back of the anus by the time a 5.0-mm mean length (day 21) was reached (Fig. 3). This species had the largest pectoral fins of any of the species described here.

Pigmentation patterns of these larvae at birth were different from the other three species (Table 1; Fig. 3). At birth, larvae had pigmentation on the dorsal surface of the gut (locus 11) and anus (loci 16 and 17); the short ventral midline series (loci 22 and 23) was composed of relatively few melanophores (mean=15.4). By a mean length of 5 mm (day 21), the majority of larvae had developed pigmentation on the lower jaw (locus 1), forebrain (locus 4), nape (locus 6; Fig. 4), otic capsule (locus 31), and cleithral symphysis (locus 28). Melanophores were also beginning to appear posteriorly on the dorsal surface of the tail (locus 19; Fig. 5) and on the margin and blade of the pectoral fins (loci 8 and 9). The second and third posterior preopercular, and pterotic spines were first observed on 4.7 mm mean standard length larvae (31 days; e.g., Fig. 3C).

Sebastes carnatus—Three field-caught pregnant *S. carnatus* gave birth in the rearing tanks during March, April, and May 1989. One of these released larvae with large yolk sacs (0.6–mm mean diameter) and large quantities of oil. First feeding of these larvae was observed after five days (4.0–mm mean SL), by which time the yolk sacs were depleted. Some of the larvae lived for 28 days. The other two females gave birth to full-term larvae that lived five and eight days. Leeches (Hirudinoidea: probably *Piscicola, Malmiana,* or *Ostreobdella* spp.) were found on three larvae from

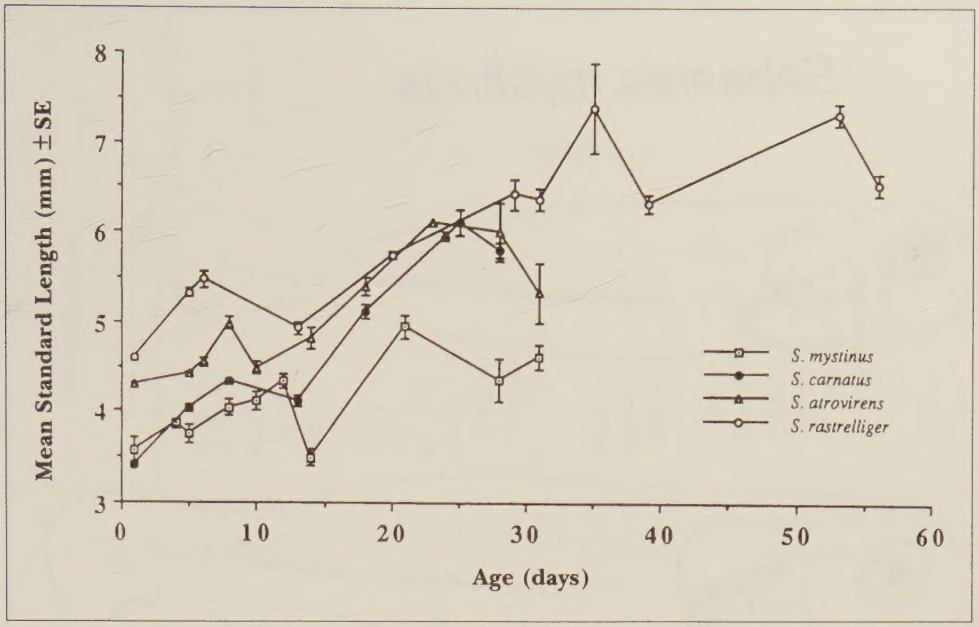

Figure 2
Mean standard length (± SE) vs. age of larvae of *Sebastes mystinus* (*n*=4), *S. carnatus* (*n*=3), *S. atrovirens* (*n*=2), *S. rastrelliger* (n=1). *n*= number of females that gave birth.

Table 1
Proportions of *Sebastes mystinus* larvae with melanophores present at loci 1–33 (see Fig. 1 for loci description).

SL (mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
3.0–3.4	1.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	1.0	0.3	1.0	0.3	0.0	0.8	0.3	1.0	1.0
3.5–3.9	0.2	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.4	1.0	0.0	0.0	0.2	0.1	1.0	1.0
4.0–4.4	0.6	0.0	0.0	0.4	0.0	0.4	0.0	0.4	0.6	0.6	1.0	0.1	0.0	0.3	0.0	0.9	1.0
4.5–4.9	1.0	0.0	0.0	1.0	0.2	0.8	0.0	0.7	1.0	0.8	1.0	0.3	0.2	0.5	0.3	0.8	1.0
5.0–5.4	1.0	0.0	0.0	1.0	0.2	1.0	0.0	1.0	1.0	1.0	1.0	0.2	0.2	0.0	0.2	1.0	1.0

SL (mm)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	*n*
3.0–3.4	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.5	0.0	0.0	4
3.5–3.9	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	38
4.0–4.4	0.1	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.2	0.0	0.0	21
4.5–4.9	0.0	0.3	0.2	0.0	1.0	1.0	0.0	0.5	0.5	0.0	0.8	0.0	0.3	0.3	0.0	0.0	6
5.0–5.4	0.0	0.4	0.6	0.0	1.0	1.0	0.0	0.4	0.4	0.0	1.0	0.0	0.0	0.8	0.0	0.0	5

the longest surviving brood at 23 days. These leeches were attached (one per larva) on the left side of the head and detached themselves when the larvae were disturbed. The parasite was probably introduced by an infected female.

The range in standard length of these larvae was 3.1 mm at birth to 6.2 mm at 28 days. The mean standard length of yolk-sac larvae was 3.4 mm (SD=0.1) at birth and 5.8 mm (SD=0.2) at 28 days (Fig. 2). The full-term larvae were 4.4–mm (SD=0.3) mean standard length at birth. The pectoral fin reached to just in front of the anus by the time a mean standard length of 4.3 mm (day 13) was attained (Fig. 6).

The yolk-sac larvae showed little pigmentation (Table 2; Fig. 6A). However, complete ventral (loci 21–23) and dorsal midline (loci 18 and 19) pigment series were present (Fig. 5) along with a few melanophores scattered laterally on the yolk-sac and a prominent antero-lateral tail melanophore (locus 27). Melanophores on the dorsal surface of the gut (locus 11), anus (loci 16 and 17), and the antero- and postero-dorsal aspect of the tail (loci 18 and 19) were also quite frequent. All individuals in the 5.0–5.4 mm

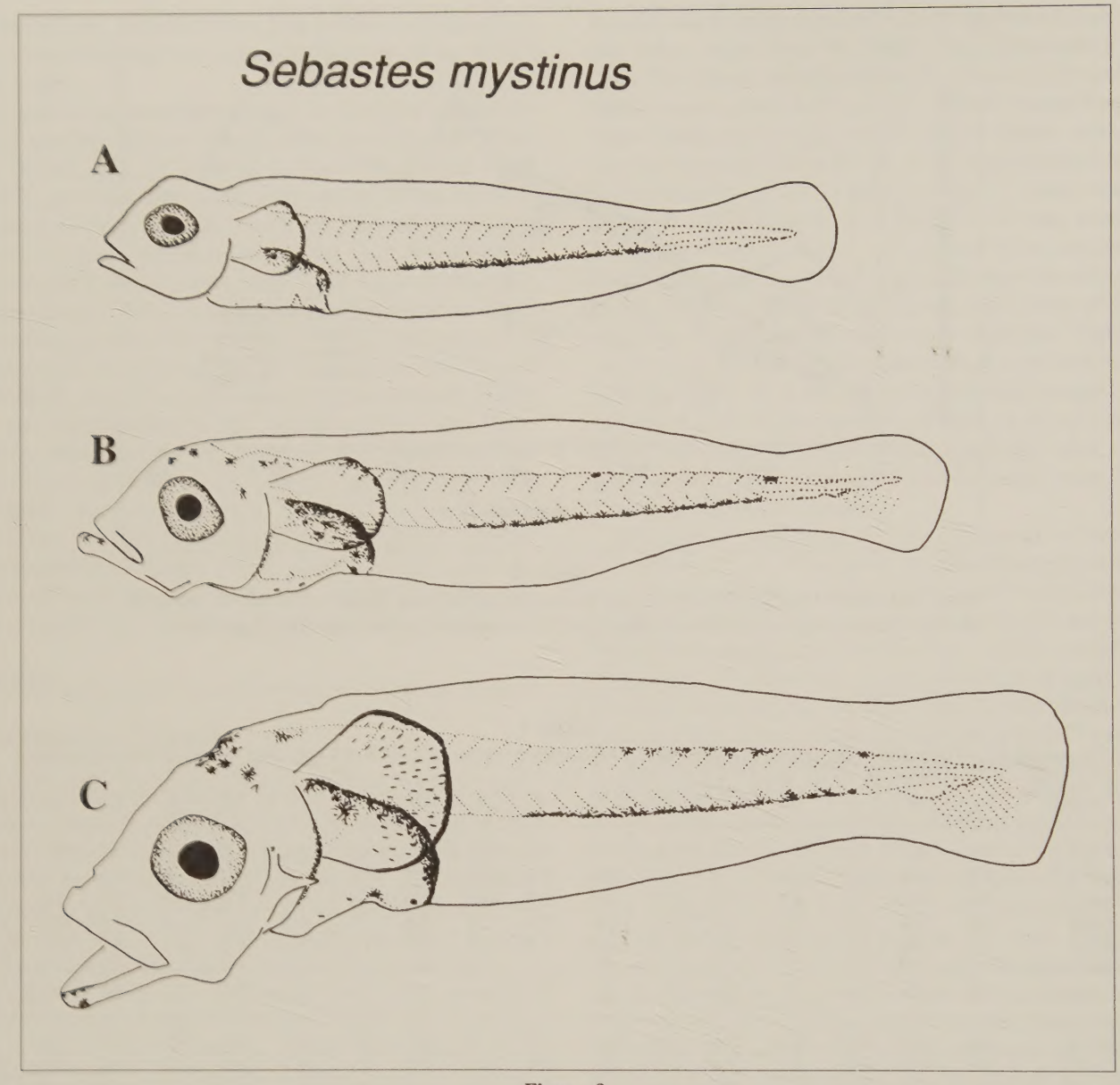

Figure 3

Sebastes mystinus larvae. (**A**) 4.2-mm SL preflexion larva; (**B**) 4.8-mm SL preflexion larva; (**C**) 5.6-mm SL preflexion larva.

size class (day 13) had pigment on the jaw (locus 1), forebrain (locus 4), nape (locus 6; Fig. 4), anus (locus 16), and ventrally on the gut (locus 10). The 6.0–6.4 mm size class (day 25) showed pigment on the maxilla (locus 2), base and border of the pectoral fins (loci 7 and 9), cleithrum (locus 28), and otic capsule (locus 31; Fig. 6C). Spination was first observed on larvae of 6.1–mm mean standard length (25 days) with the appearance of the second and third posterior preoperculars, pterotic, and parietal spines (Fig. 6C).

Sebastes atrovirens—Larvae of *S. atrovirens* were obtained from two females removed from the MBA Kelp Tank in May 1988 and June 1989. One female spawned naturally in the rearing tank, the other gave birth on capture to larvae and unfertilized eggs (0.8–mm mean diameter). The newborn larvae from both broods were of comparable sizes and developmental stages. Larvae from the full-term brood lived eight days; some from the mixed brood lived for 30 days.

The range of larval standard length was between 4.0 mm at birth and 6.5 mm at day 30. The mean standard length at birth was 4.3 mm (SD=0.2) with a mean of 5.3 mm (SD=0.6) at 30 days (Fig. 2). The pectoral fins extended to just in front of the anus by the time a mean length of 4.5 mm (day 10) was reached (Fig. 7).

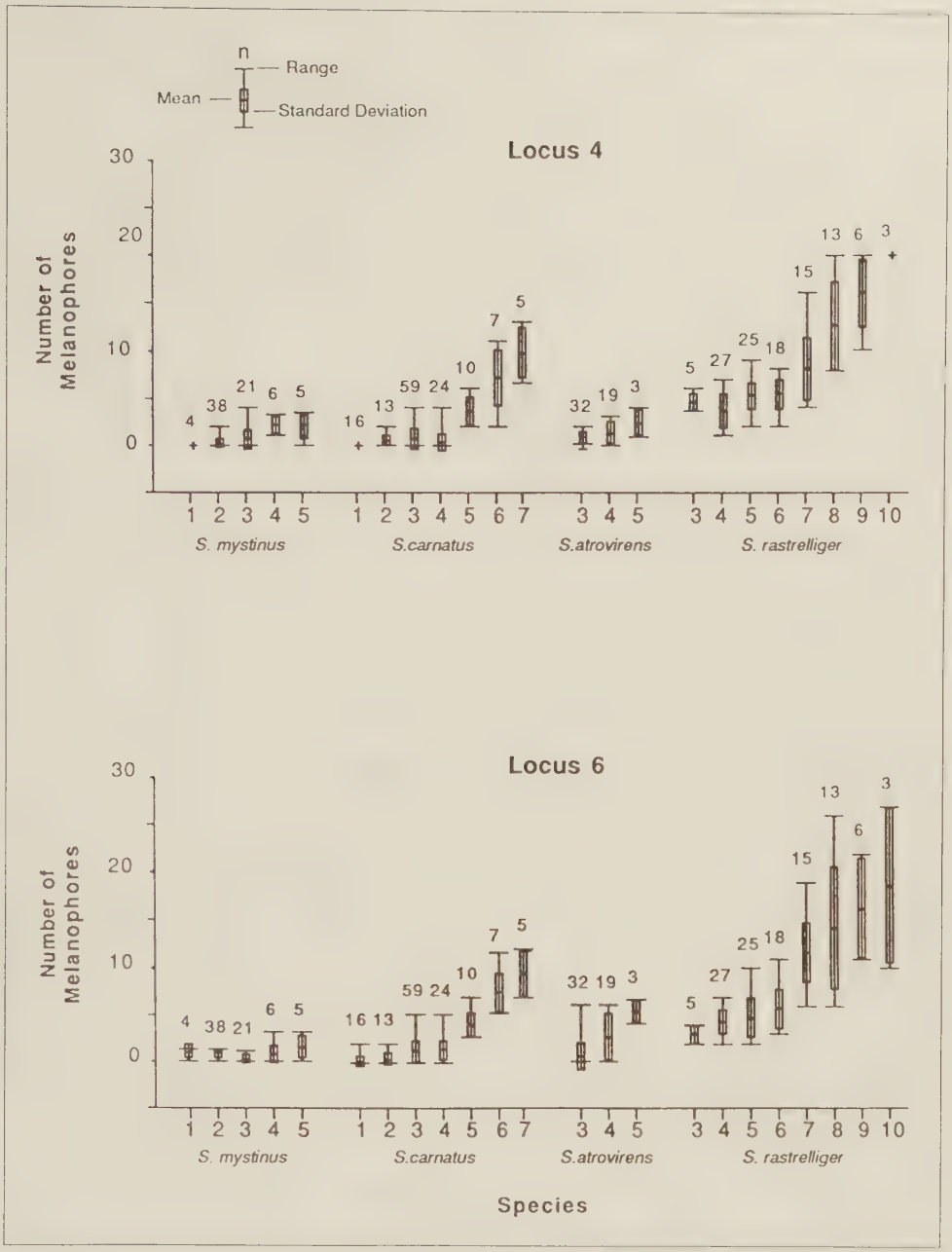

Figure 4

Melanophore densities (mean number per larva) at locus 4 and locus 6 of each size class for all species. 1= 3.0–3.4 mm; 2= 3.5–3.9 mm; 3= 4.0–4.4 mm; 4= 4.5–4.9 mm; 5= 5.0–5.4 mm; 6= 5.5–5.9 mm; 7= 6.0–6.4 mm; 8= 6.5–6.9 mm; 9= 7.0–7.4 mm; 10= 7.5–7.9 mm.

At birth, *S. atrovirens* larvae were similar to *S. carnatus* with pigmentation on the ventral and dorsal aspects of the gut (loci 10 and 11), the anus (locus 16), posterior aspect of the hindgut (locus 17), postero-dorsal midline of the tail (locus 19), and a complete ventral midline series (loci 21–23) (Table 3; Fig. 7). With development, increasing proportions of larvae showed pigmentation on the lower jaw (locus 1), forebrain (locus 4), nape (locus 6; Fig. 4), anterior dorsal midline (locus 18; Fig. 5), and otic capsule (locus 31) . With continued growth, pigmentation appeared on the posterior and postero-ventral surfaces of the gut (loci 12 and 13), cleithrum (locus 28), and lower jaw (locus 29). The pigmentation patterns of *S. atrovirens* and *S. carnatus* remained extremely similar throughout all stages (see Pigmentation in Species Comparisons Section for explanation of differences). No head spine development was apparent during the 30 days (Fig. 7D).

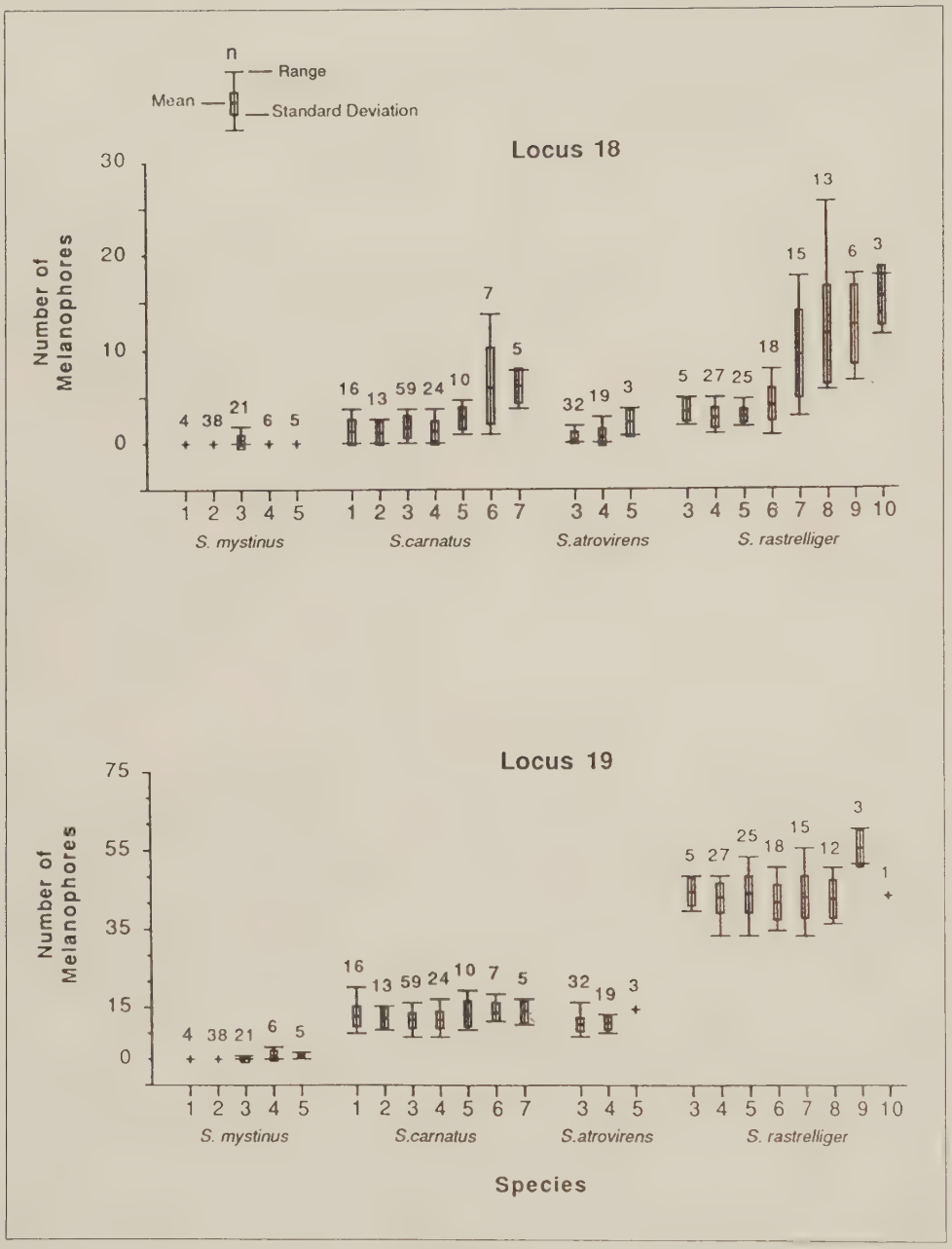

Figure 5

Melanophore densities (mean number per larva) at locus 18 and locus 19 of each size class for all species. 1= 3.0–3.4 mm; 2= 3.5–3.9 mm; 3= 4.0–4.4 mm; 4= 4.5–4.9 mm; 5= 5.0–5.4 mm; 6= 5.5–5.9 mm; 7= 6.0–6.4 mm; 8= 6.5–6.9 mm; 9= 7.0–7.4 mm; 10= 7.5–7.9 mm.

Sebastes rastrelliger—One female *S. rastrelliger* removed from the MBA Kelp Tank in mid-February 1989 gave birth on capture, but the larvae appeared to be full-term because no yolk sacs or oil globules were present. Some of these larvae lived up to 56 days.

Larval sizes ranged from 4.3 mm at birth to 7.7 mm at day 52. The mean length at birth was 4.6 mm (SD=0.1) and at day 56 was 6.6 mm (SD=0.3; Fig. 2). The pectoral fins in this species were smaller than the other species, reaching to ~75% of the gut length (Fig. 8).

This was the most highly pigmented of the four species described (Table 4; Fig. 8). The newborn larvae had completely pigmented dorsal and ventral midline series and pigmentation on the forebrain and nape (loci 4 and 6). Melanophore numbers at these loci increased from a mean of 4.6 and 3.0 at birth to 20.0 and 18.7 at 7.5–7.9 mm (Fig. 4). Melanophores on the jaw, maxilla, and posterior half of the jaw (loci 1–3), were sometimes present at birth, and were present on all larvae by the time a 6.0–6.4

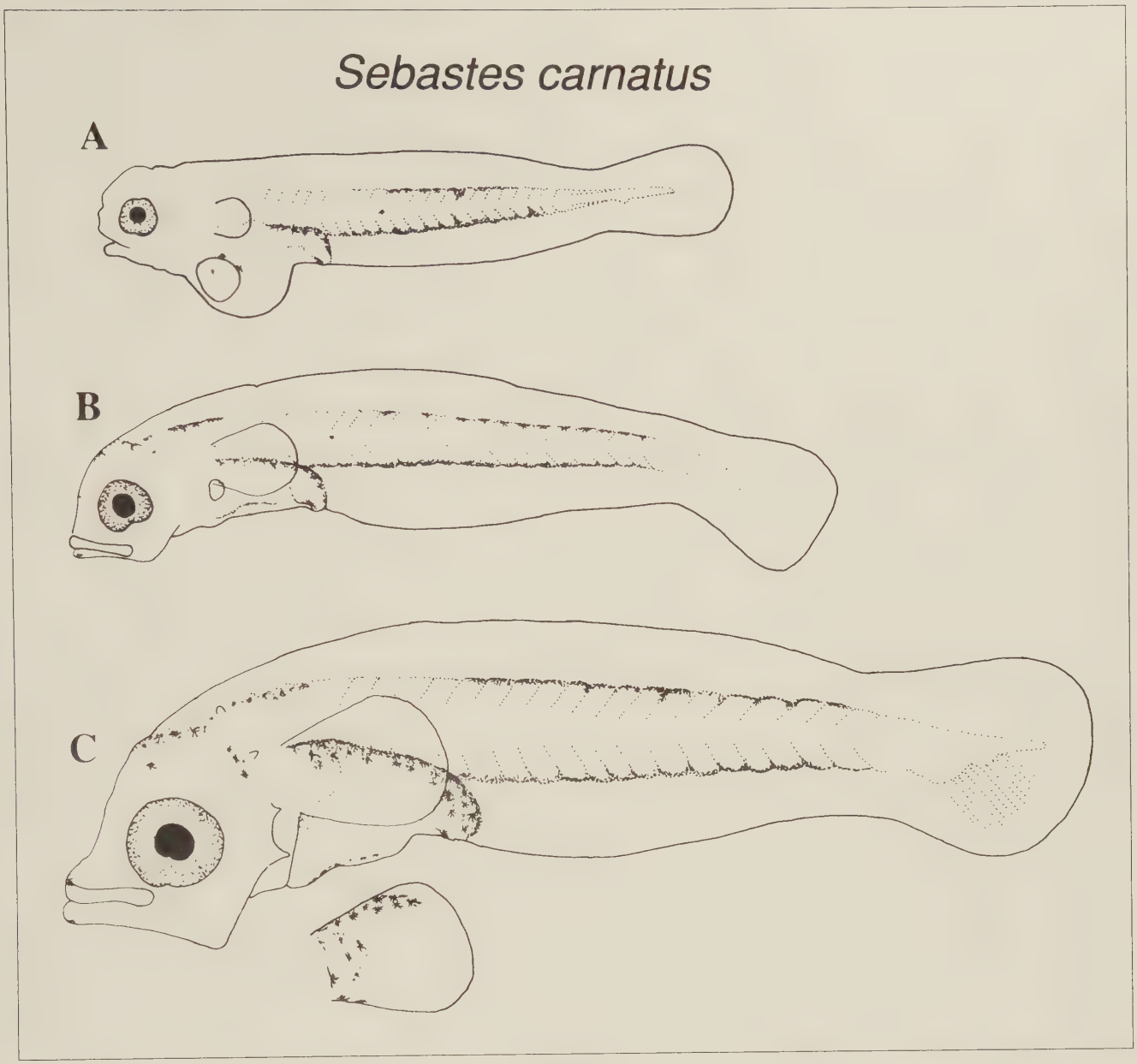

Figure 6

Sebastes carnatus larvae. (**A**) 3.5-mm SL yolk-sac larva; (**B**) 4.3-mm SL preflexion larva; (**C**) 6.0-mm standard length preflexion larva.

mm length was reached (Table 4). Melanophore density in the antero-dorsal midline series (locus 18) increased from 3.6 to 15.7. The postero-dorsal midline series (locus 19) also increased, from a mean of 44 to >44 at 7.5–7.9 mm (Fig. 5). Because of the dense arrangement of melanophores, it was not possible to quantify their exact number at this locus. Distinctive postero-lateral tail pigment (loci 24 and 33). was present on most 5.0–5.4 mm larvae and present in all 6.5–6.9 mm larvae. This pigmentation was also seen on similar-sized *S. carnatus* larvae.

Spination was present on larvae of 6.3–mm mean standard length at 29 days: the parietal, pterotic, second and third anterior preoperculars, second, third, and fourth posterior preoperculars, upper opercular, and postocular spines were present (Fig. 8C). By 7.4–mm mean standard length at 34 days the parietal, pterotic, first, second, and third anterior preoperculars, second, third, and fourth posterior preoperculars, upper opercular, and postocular spines were observed (Fig. 8D). Hypural elements were developed on 7.4–mm mean standard length larvae (34 days old).

Table 2
Proportions of *Sebastes carnatus* larvae with melanophores present at loci 1–33 (see Fig. 1 for loci description).

SL (mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
3.0–3.4	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	1.0	0.1	0.0	0.0	0.0	1.0	10.
3.5–3.9	0.4	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.5	1.0	0.0	0.0	0.3	0.2	0.9	1.0
4.0–4.4	0.2	0.0	0.0	0.3	0.0	0.7	0.0	0.0	0.0	0.9	1.0	0.1	0.2	0.2	0.1	1.0	10.
4.5–4.9	0.1	0.0	0.0	0.1	0.0	0.8	0.0	0.0	0.0	0.8	10	0.0	0.0	0.1	0.0	1.0	1.0
5.0–5.4	1.0	0.5	0.5	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.1	0.1	0.0	1.0	1.0	1.0
5.5–5.9	1.0	0.4	0.6	1.0	0.0	1.0	0.9	0.0	0.7	1.0	1.0	0.7	0.4	0.1	0.9	1.0	1.0
6.0–6.4	1.0	0.8	0.6	1.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	1.0	1.0	0.4	1.0	1.0	1.0

SL (mm)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	*n*
3.0–3.4	0.8	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	010	0.0	0.0	16
3.5–3.9	0.6	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.5	0.2	0.0	0.0	0.4	0.0	0.0	13
4.0–4.4	0.9	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.3	0.0	0.0	59
4.5–4.9	0.8	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0;	0.1	0.0	0.0	24
5.0–5.4	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	1.0	0.4	0.0	1.0	0.0	0.0	10
5.5–5.9	1.0	1.0	0.0	1.0	1.0	1.0	0.7	0.0	0.1	0.1	1.0	0.1	0.0	1.0	0.0	0.3	7
6.0–6.4	1.0	1.0	0.0	1.0	1.0	1.0	0.8	0.0	0.0	0.6	1.0	1.0	0.0	1.0	0.0	0.6	5

Table 3
Proportions of *Sebastes atrovirens* larvae with melanophores present at loci 1–33 (see Fig. 1 for loci description).

SL (mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
4.0–4.4	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.1	0.0	1.0	1.0
4.5–4.9	0.2	0.0	0.0	0.6	0.0	0.6	0.0	0.0	0.0	1.0	1.0	0.1	0.1	0.1	0.1	1.0	1.0
5.0–5.4	1.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.3	0.3	0.0	0.0	1.0	1.0

SL (mm)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	*n*
4.0–4.4	0.3	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	32
4.5–4.9	0.4	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	19
5.0–5.4	1.0	1.0	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.7	0.3	0.0	0.7	0.0	0.0	3

Species Comparisons

Morphometrics—*Sebastes mystinus* was characterized by having a relatively longer snout (SNL/HL), and deeper body (BD/SL) than the other species at similar sizes. In addition, this species had a larger head (HL/SL) in relation to body length (Tables 5–8). Although not measured, this species had the largest pectoral fins. On larvae 4.8 mm or larger, the fins extended behind the anus (Fig. 3).

Sebastes carnatus appeared to have a longer gut (SA/SL) than *S. rastrelliger* for all size classes. It also had a longer snout (SNL/HL) than *S. atrovirens* and *S. rastrelliger* in the 4.0–6.4 mm ranges (Tables 6–8).

Sebastes atrovirens had a longer gut (SA/SL), than the other species except *S. carnatus* at the 4.0–4.4 mm and 5.5–6.4 mm ranges. More notably, this species had large eyes (ED/HL) that may help to distinguish it from the very similar *S. carnatus* larvae (Tables 6 and 7).

Sebastes rastrelliger, along with *S. mystinus*, had a relatively shorter gut (SA/SL), and deeper body (BD/SL) compared with the other species. It also had smaller eyes (ED/HL) than did *S. mystinus* and *S. carnatus* (Tables 5, 6 and 8).

Pigmentation—The pigment patterns which help to differentiate *S. mystinus* from the other species described are 1) a short row of ventral midline melanophore series (loci 22 and 23); 2) absence of dorsal midline pigment on the early larvae, and presence of relatively sparse postero-dorsal midline pigment (lo-

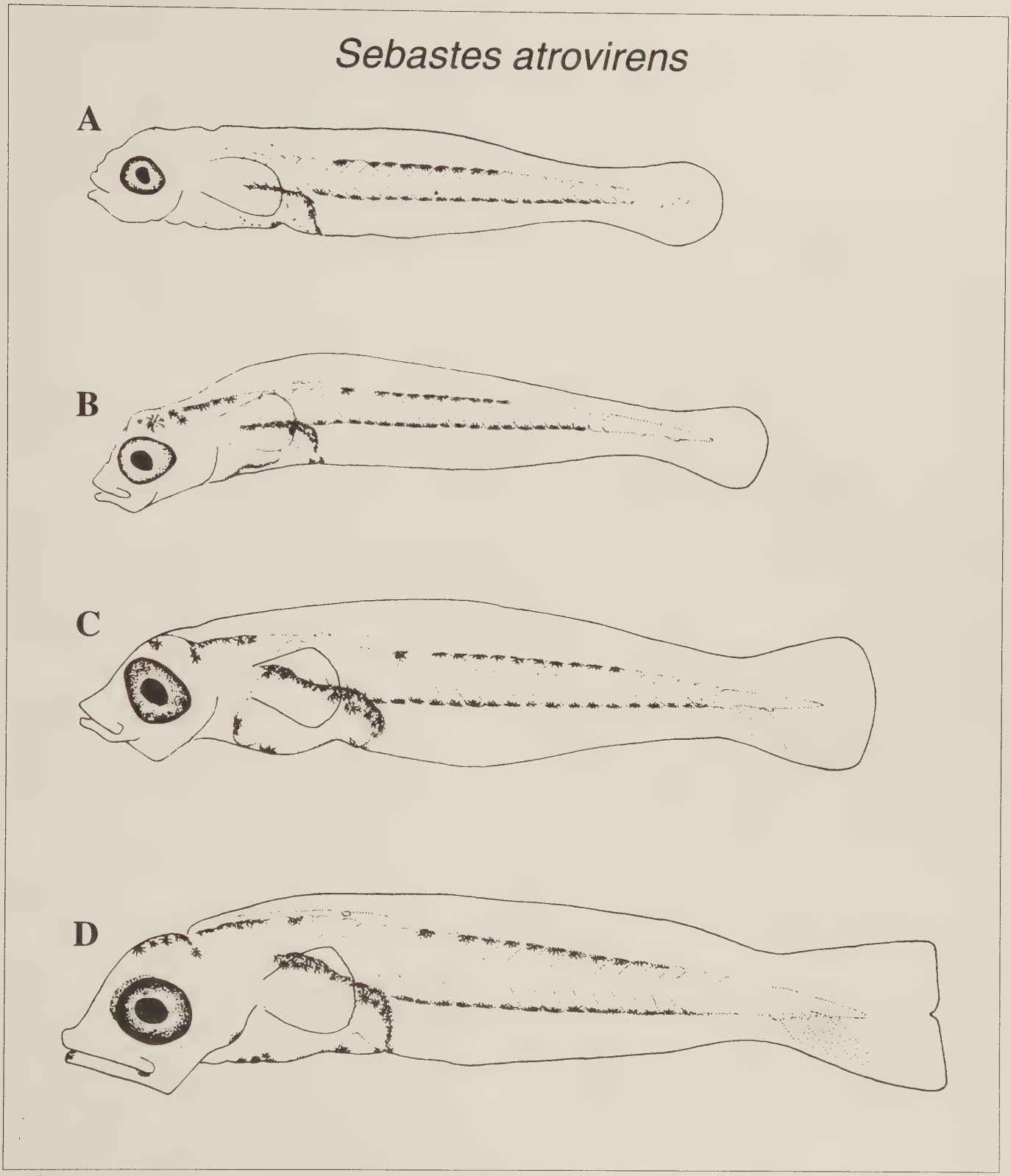

Figure 7

Sebastes atrovirens larvae. (**A**) 4.4-mm SL preflexion larva; (**B**) 4.6-mm SL preflexion larva; (**C**) 5.4-mm SL preflexion larva; (**D**) 5.9-mm SL preflexion larva.

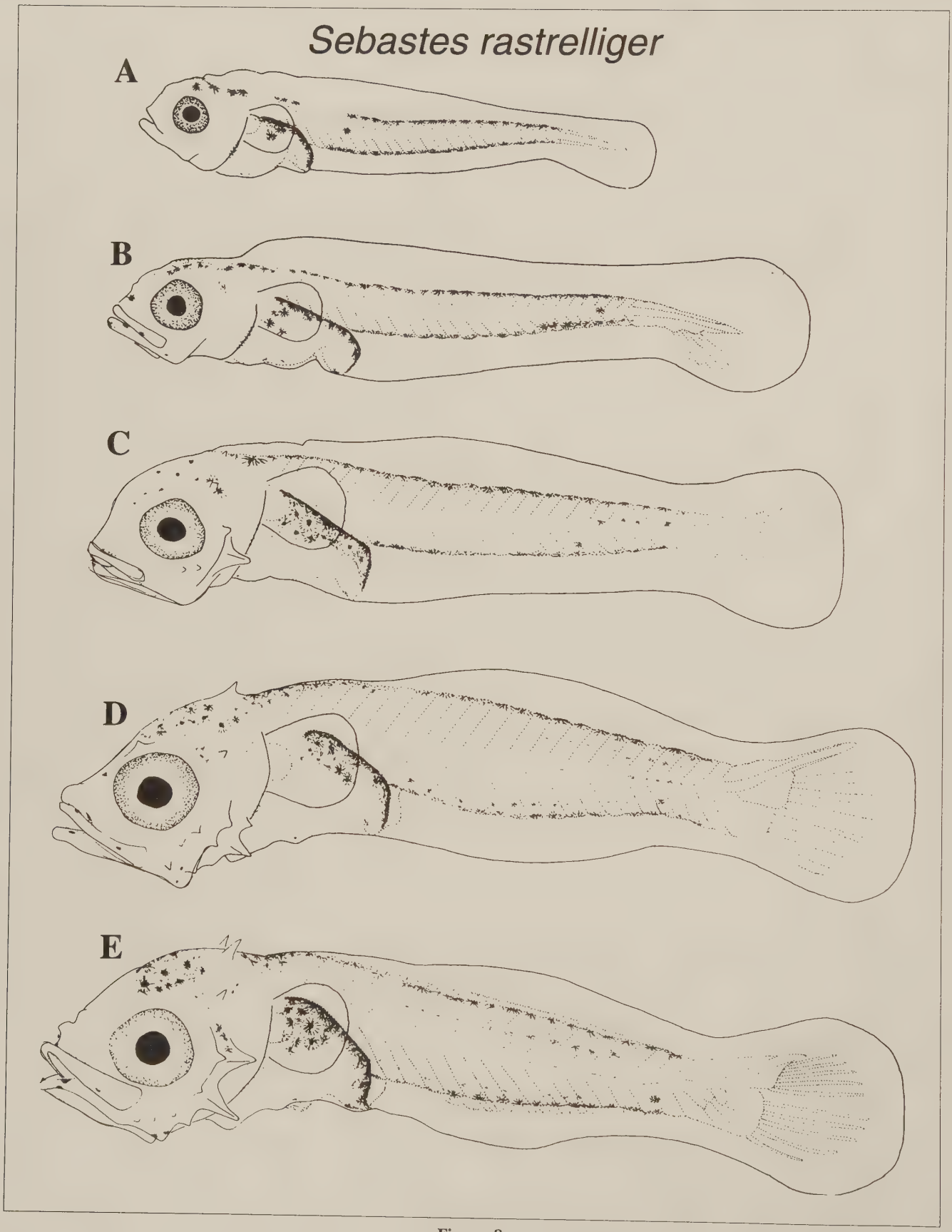

Figure 8

Sebastes rastrelliger larvae. (**A**) 4.6-mm SL yolk-sac larva; (**B**) 5.8-mm SL preflexion larva; (**C**) 6.4-mm SL flexion larva; (**D**) 7.2-mm SL flexion larva; (**E**) 7.0-mm flexion larva.

Table 4

Proportions of *Sebastes rastrelliger* larvae with melanophores present at loci 1–33 (see Fig. 1 for loci description).

SL (mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
4.0–4.4	0.6	0.4	0.4	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.4	1.0
4.5–4.9	0.3	0.2	0.3	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.1	0.1	0.4	1.0
5.0–5.4	1.0	1.0	0.8	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.2	0.0	0.0	0.0	0.7	1.0
5.5–5.9	1.0	0.9	0.9	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.3	0.8	1.0
6.0–6.4	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	0.9	1.0	0.0	0.1	0.0	0.3	1.0	1.0
6.5–6.9	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.4	1.0	1.0
7.0–7.4	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.3	0.0	0.0	0.3	0.5	1.0
7.5–7.9	1.0	1.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.7	1.0

SL (mm)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	*n*
4.0–4.4	1.0	1.0	0.0	1.0	1.0	1.0	0.6	0.0	0.0	0.2	0.4	0.2	0.0	0.0	0.4	0.0	5
4.5–4.9	1.0	1.0	0.0	1.0	1.0	1.0	0.6	0.0	0.0	0.3	0.7	0.3	0.0	0.3	0.3	0.0	27
5.0–5.4	1.0	1.0	0.0	1.0	1.0	1.0	0.9	0.0	0.0	0.1	1.0	0.8	0.0	0.7	0.9	0.0	25
5.5–5.9	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.8	0.0	0.9	0.9	0.8	18
6.0–6.4	1.0	1.0	0.0	1.0	1.0	1.0	0.9	0.0	0.0	0.1	1.0	0.8	0.0	0.9	0.9	0.8	15
6.5–6.9	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	0.9	0.0	0.9	1.0	1.0	13
7.0–7.4	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	6
7.5–7.9	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	0.7	1.0	1.0	3

Table 5

Morphometric proportions of *Sebastes mystinus* larvae. Mean ± standard deviation, with the ranges in parentheses. SA/SL = snout-anus length/standard length; HL/SL = head length/standard length; SNL/HL=snout length/head length; ED/HL = eye diameter/head length; BD/SL = body depth/standard length.

SL (mm)	SA/SL	HL/SL	SNL/HL	ED/HL	BD/SL	*n*
3.0–3.4	39.4±1.9 (38.2–40.6)	24.2±1.9 (21.8–26.4)	37.8±3.9 (33.3–42.8)	37.8±3.9 (33.3–42.8)	18.9±1.6 (17.6–21.2)	4
3.5–3.9	34.9±2.2 (28.2–38.8)	19.4±1.6 (15.3–23.0)	42.1±5.1 (33.3–57.1)	37.8±6.9 (25.0–50.0)	16.5±1.3 (12.8–19.4)	38
4.0–4.4	34.9±1.7 (31.7–39.5)	20.6±1.7 (18.6–25.0)	37.2±5.1 (25.0–45.4)	35.8±3.4 (25.0–40.0)	15.9±2.0 (12.1–19.5)	21
4.5–4.9	37.7±1.4 (35.5–39.1)	22.6±2.0 (20.0–26.0)	46.0±5.4 (40.0–54.5)	30.5±5.5 25.0–40.0)	17.2±1.9 (15.2–19.5)	6
5.0–5.4	37.2±1.0 (36.0–38.4)	22.7±1.0 (21.5–24.0)	48.3±4.9 (41.6–54.5)	34.5±1.6 (33.3–36.3)	17.6±1.5 (16.0–20.0)	5

cus 19; Fig. 5) in larger specimens; and 3) presence of pigment on the pectoral fins (loci 8 and 9) with melanophores scattered over the fin rays and concentrated on the margin (Fig. 3).

Sebastes carnatus (Fig. 6) and *S. atrovirens* (Fig. 7) can be differentiated from *S. mystinus* (Fig. 3) by 1) presence of a long ventral midline melanophore series (loci 21–23); and 2) a greater number of melanophores on the dorsal midline (loci 18 and 19; Fig. 5). They can be differentiated from *S. rastrelliger* (Fig. 8) by the overall more pronounced pigmentation on the latter. *Sebastes carnatus* can be differentiated from similarly pigmented *S. atrovirens* by the following characters: 1) presence (up to 0.9) of antero-lateral tail pigment (locus 27; Tables 2 and 3); 2) presence of melanophores on the base and anterior margin of the pectoral fins (loci 7 and 9); and 3) presence of melanophores on the mid-upper and mid-lower jaw (loci 2 and 3; Table 2; Fig. 6).

Sebastes rastrelliger can be differentiated by the following patterns: 1) heavily pigmented head (loci 1–4 and 6; Figs. 4 and 8) with presence of melanophores

Table 6

Morphometric proportions of *Sebastes carnatus* larvae. Mean ± standard deviation, with the ranges in parentheses. SA/SL = snout-anus length/standard length; HL/SL = head length/standard length; SNL/HL=snout length/head length; ED/HL = eye diameter/head length; BD/SL = body depth/standard length.

SL (mm)	SA/SL	HL/SL	SNL/HL	ED/HL	BD/SL	*n*
3.0–3.4	40.5±2.6 (35.2–45.1)	15.9±2.2 (11.7–21.2)	24.6±7.9 (16.6–40.0)	41.2±5.0 (33.3–50.0)	9.8±4.5 5.8–21.2)	16
3.5–3.9	39.7±1.9 (37.1–44.4)	17.8±2.6 (14.2–22.2)	34.1±7.4 (20.0–42.8)	37.7±7.9 (28.5–60.0)	12.4±4.5 (5.5–17.9)	14
4.0–4.4	38.8±2.0 (34.8–42.8)	18.7±1.6 (15.9–23.2)	34.2±6.0 (25.0–50.0)	37.0±5.8 (25.0–50.0)	13.3±5.0 (2.0–19.0)	59
4.5–4.9	36.8±1.4 (34.7–40.0)	18.5±1.1 (17.0–20.0)	32.9±5.1 (22.2–37.5)	35.3±7.1 (22.2–50.0)	14.5±1.4 (12.7–17.7)	24
5.0–5.4	37.8±1.5 (35.8–40.7)	20.5±1.0 (19.2–22.2)	33.6±4.1 (27.2–40.0)	34.6±4.3 (27.2–40.0)	17.5±6.3 (14.0–35.1)	10
5.5–5.9	42.4±1.8 (39.6–44.8)	24.2±1.7 (22.0–27.1)	32.2±3.9 (26.6–37.5)	33.3±2.4 (30.7–35.7)	20.0±1.4 (17.5–22.0)	7
6.0–6.4	42.8±1.8 (40.0–45.1)	24.6±1.9 (21.6–26.2)	32.9±4.0 (30.7–40.0)	36.9±3.4 (31.2–40.0)	21.4±1.0 (20.0–22.5)	5

Table 7

Morphometric proportions of *Sebastes atrovirens* larvae. Mean ± standard deviation, with the ranges in parentheses. SA/SL = snout-anus length/standard length; HL/SL = head length/standard length; SNL/HL=snout length/head length; ED/HL = eye diameter/head length; BD/SL = body depth/standard length.

SL (mm)	SA/SL	HL/SL	SNL/HL	ED/HL	BD/SL	*n*
4.0–4.4	38.1±2.1 (34.0–43.9)	18.8±2.1 (13.9–23.8)	31.0±6.5 (12.5–44.4)	37.8±6.1 (22.2–57.1)	14.1±1.9 (11.3–18.6)	50
4.5–4.9	38.0±2.7 (33.3–44.8)	19.4±2.2 (15.2–28.4)	28.3±5.4 (20.0–40.0)	38.1±5.7 (25.0–50.0)	13.4±2.1 (10.6–18.3)	38
5.0–5.4	39.9±2.8 (35.8–45.0)	21.8±3.1 (18.8–29.4)	27.6±7.3 (16.6–40.0)	39.1±2.2 (36.3–41.6)	14.3±1.6 (11.3–16.6)	9
5.5–5.9	41.8	21.8	25.0	50.0	14.5	1
6.0–6.4	42.2±1.8 (40.9–44.2)	24.7±3.1 (22.9–28.3)	24.1±4.6 (21.4–29.4)	42.7±7.4 (35.2–50.0)	17.5±2.1 (16.3–19.9)	3

on the nares (locus 32); 2) complete, heavily pigmented dorsal midline series (loci 18 and 19; Fig. 5) from birth; and 3) external and internal pigmentation on the postero-lateral portion of the tail (loci 24 and 33) in larvae >5.0 mm (Table 4; Fig. 8). The extent and concentration of ventral midline pigment (loci 21–23) is similar to that of *S. carnatus* and *S. atrovirens*.

Discussion

The traditional size-series method may not be practical for all species of *Sebastes*, because many field-caught *Sebastes* larvae smaller than 8–10 mm cannot be identified with confidence (Kendall and Lenarz, 1987). The very early stages of *S. carnatus*, *S. atrovirens* (this study), *S. chrysomelas* (Wold, 1990), *S. auriculatus*

Table 8

Morphometric proportions of *Sebastes rastrelliger* larvae. Mean ± standard deviation, with the ranges in parentheses. SA/SL = snout-anus length/standard length; HL/SL = head length/standard length; SNL/HL=snout length/head length; ED/HL = eye diameter/head length; BD/SL = body depth/standard length.

SL (mm)	SA/SL	HL/SL	SNL/HL	ED/HL	BD/SL	*n*
4.0–4.4	34.2±2.1 (31.8–36.5)	19.9±1.7 (18.1–21.9)	30.0±4.5 (25.0–33.3)	37.2±4.5 (33.3–44.4)	16.1±1.3 (14.6–18.1)	5
4.5–4.9	34.5±2.1 (29.7–37.5)	18.9±1.3 (16.3–21.2)	28.8±5.2 (22.2–37.5)	36.8±5.4 (30.0–55.5)	15.6±1.4 (12.5–17.7)	25
5.0–5.4	35.3±1.8 (31.4–38.0)	19.6±2.3 (16.6–25.9)	30.2±4.9 (20.0–36.3)	35.8±5.2 (27.2–44.4)	14.7±1.4 (11.1–16.7)	25
5.5–5.9	38.0±2.8 (32.7–41.0)	20.3±1.9 (17.5–25.4)	32.8±4.1 (25.0–41.6)	39.1±4.8 (30.7–46.1)	15.9±1.9 (12.0–18.6)	18
6.0–6.4	40.1±1.7 (37.5–43.3)	24.4±2.4 (20.9–28.3)	30.0±4.1 (26.6–42.8)	35.3±4.8 (26.6–42.8)	17.4±1.9 (14.7–20.9)	15
6.5–6.9	40.2±2.4 (34.8–43.0)	24.7±1.3 (22.7–26.4)	30.8±2.4 (25.0–33.3)	37.3±3.7 (31.2–43.7)	17.9±1.9 (15.4–21.4)	13
7.0–7.4	40.5±2.2 (37.1–43.0)	25.0±1.7 (22.8–27.7)	30.9±3.3 (25.0–33.3)	44.4±5.0 (38.8–50.0)	20.3±1.2 (18.5–22.2)	6
7.5–7.9	42.8±1.4 (41.5–44.3)	26.3±0.4 (25.9–26.6)	32.8±6.3 (28.5–40.0)	39.3±1.2 (38.0–40.0)	19.8±2.2 (17.3–21.5)	3

and *S. caurinus* (Stahl-Johnson, 1985) show great similarities and are difficult to differentiate from each other.

Of the 51 species of eastern Pacific *Sebastes* larvae previously described, only nine descriptions have been based on reared specimens (Moser and Butler, 1981, 1987; Stahl-Johnson, 1985; Kendall, 1989; Wold, 1990) mainly because of the difficulty of rearing larvae past yolk-sac to juvenile stage. Such difficulties arise from the relatively small size, early developmental level at birth, feeding problems and importantly, slow larval growth rates shown for eastern Pacific species (Moser and Butler, 1987).

A major concern in rearing *Sebastes* is the need for healthy full-term larvae (Westrheim, 1975). Most information on the early larval stages of rockfishes comes from descriptions of pre-extrusion larvae. However, pigment patterns are not well established in yolk-sac *Sebastes* larvae, making these descriptions unreliable for the identification of more advanced stages (Westrheim, 1975). Because of the use of SCUBA-aided capture techniques, premature birth was alleviated for the nearshore *Sebastes* species described here.

The months of parturition observed for two (*S. mystinus, S.carnatus*) of the four species were similar to those reported by Wyllie-Echeverria (1987). There is no published information on parturition periods of *S. atrovirens* or *S. rastrelliger. Sebastes* species seem to have two major seasons of larval extrusion, winter and spring-summer (Phillips, 1964). *Sebastes mystinus* and *S. rastrelliger* gave birth in the winter season (November–March), and *S. atrovirens* in the spring-summer season (April–July). *Sebastes carnatus* overlapped both seasons with March–May parturitions.

Only the larvae of *S. rastrelliger* were maintained past the preflexion stage. These larvae lived for up to 56 days and went through flexion but did not reach postflexion. The data presented here for the other three species are still useful since small, preflexion forms (e.g., ≤7 mm) generally dominate (>90%) the *Sebastes* larvae caught off California by net sampling operations (Moser and Butler, 1987).

To describe these larvae, it was necessary to choose a character, either age or size, to allow an evaluation of variability, and a determination of useful specific identifying characters. As in most studies of *Sebastes* larvae, size was used instead of age. This was done because 1) grouping by age is a slow and expensive process in field studies and 2) size rather than age appears to be a better indicator of development, although there is variability in both. Policansky (1982) found that size (length), and not age, was the single

most important determinant in the timing of metamorphosis of the starry flounder, *Platichthys stellatus*.

It is relatively easy to identify two (*S. mystinus*, *S. rastrelliger*) of the four species described here by pigmentation patterns. However, morphometric measurements did not yield differences useful for positive identification of species. *Sebastes mystinus* had larger pectoral fins than the other species, but because of the difficulty in measuring the unpigmented pectoral fins of the other species it was not possible to compare them. *Sebastes carnatus* and *S. atrovirens* are very similar and pigmentation alone will not be enough to identify all the stages of either species. These larvae show the following morphometric differences: *S. carnatus* has a longer snout (SNL/HL) and deeper body (BD/SL), whereas *S. atrovirens* has a larger eye diameter (ED/HL). Parturition times and range information are also important to decide which species may be present in the plankton at a certain time and place.

Two distinct pigmentation patterns can be discerned among the larvae described here: 1) a short row of ventral melanophores and no, or very little, postero-dorsal pigmentation (*S. mystinus*); and 2) complete ventral pigmentation (e.g., all three loci pigmented) and anterior and postero-dorsal melanophores (*S. carnatus*, *S. atrovirens*, and *S. rastrelliger*). *Sebastes mystinus* had pigmentation on the head and on the margin and blade of the pectoral fins. *Sebastes carnatus* and *S. atrovirens* had similar melanophore patterns in the very early stages; *S. carnatus* differed in the later stages by addition of melanophores to the base and margin of the pectoral fin. *Sebastes rastrelliger* was the most pigmented species with a greater number of pigmented loci and more melanophores per locus than any of the other species. Among these four species, *S. rastrelliger* was unique in having melanophores on the nares. The internal posterolateral pigmentation on the tail of *S. rastrelliger* and *S. carnatus* is also present in *S. caurinus* and *S. auriculatus* (Stahl-Johnson, 1985) and may commonly be found in older larvae.

Other approaches to the identification of *Sebastes* larvae include capture and rearing of planktonic larvae (Kendall, 1991) and electrophoretic techniques (Seeb and Kendall, 1991). However, these methods have limitations as well. Capture of viable *Sebastes* larvae is difficult since they are extremely delicate and are not very accessible (e.g., most individuals are collected at ca. 40–m depths; Ahlstrom, 1959). In addition, a typical plankton tow takes about 20 minutes (Smith and Richardson, 1977), whereas autolytic tissue decomposition may start within two to three minutes after sampling (O'Connell, 1980; Setzler-Hamilton et al., 1987) possibly affecting electrophoretic results.

Some investigators (Morris, 1956; DeLacy et al., 1964; Moser, 1967; Efremenko and Lisovenko, 1970; Westrheim, 1975) have expressed doubts about the possibility of identifying field-caught *Sebastes* larvae because of small interspecific differences and large intraspecific variability. However, some species whose larvae have already been described are identifiable in spite of these problems. Researchers need to describe in more detail the degree of variability of characters commonly used for species identification (e.g., pigmentation).

Although difficult, rearing of *Sebastes* species can provide not only reliable descriptions but also useful information on various life history aspects. In the case of closely related species, this technique could partially eliminate the uncertainty associated with descriptions from field samples. In addition, culturing can provide much needed data on larval growth, age, and behavior.

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